NOTES ON THE *MATELEA BAYATENSIS-CORRELLII-TIGRINA* COMPLEX (APOCYNACEAE: ASCLEPIADOIDEAE: GONOLOBINAE) IN THE GREATER ANTILLES AND BAHAMAS

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ABSTRACT

As a component of a larger study of the West Indian *Matelea* subgenus *Ptycanthera*, this study sought to critically examine patterns of morphological variation within the embedded *M. bayatensis-correllii-tigrina* complex. Resolution of species-level circumscriptions are necessary before larger issues of subgeneric and generic circumscription can be adequately addressed. Morphological characters were analyzed using parsimony analysis, neighbor-joining, and ANOVA. Results show that *Matelea bayatensis*, *M. correllii*, and *M. tigrina* are very closely related morphologically. The three species appear to differ only in pubescence and relatively minor floral character states, some of which overlap. At present, none of the observed variation appears important enough to warrant the continued recognition of three distinct species.

RESUMEN

Este estudio es un componente de otro más amplio de *Matelea* subgenus *Ptycanthera* delas Indias Occidentales, y está dedicado a examinar criticamente los patrones de variación morfológica en el complejo *M. bayatensis-correllii-tigrina*. Se necesita la resolución de las circunscripciones a nivel específico antes de abordar las circunscripciones de los géneros y subgéneros adecuadamente. Los caracteres morfológicos se analizaron usando análisis de parsimonia, del vecino más próximo, y ANOVA. Los resultados muestran que *Matelea bayatensis*, *M. correllii*, y *M. tigrina* están muy relacionados morfológicamente. Las tres especies parecen diferir sólo en la pubescencia y estados de carácter florales relativamente menores, algunos de los cuales se solapan. Actualmente, ninguna de las variaciones observadas parece lo suficiente importante como para justificar el reconocimiento de tres especies diferentes.

The Metastelmatinae-Oxypetalinae-Gonolobinae clade sensu Rapini et al. (2003) is the most morphologically diverse of the New World Asclepiadeae and most members have never been monographed. The circumscription of two Gonolobinae genera—*Gonolobus* Michx. and *Matelea* Aubl.—has been particularly complicated by the swelling of the latter by Woodson (1941). Unable to come to terms with the large variation in corona morphology, Woodson (1941) submerged numerous genera within *Matelea*, increasing its size from four to over 100 species. Estimates of species numbers of *Gonolobus* vary from 100 to 150 (Rosatti 1989; Mabberly 1997; Stevens 2001). The degree of variation is largely the result of differences regarding generic limits, as well as still poorly known

tropical taxa. Woodson (1941) considered the entirely Antillean subgenus *Ptycanthera* to be "largely the deciding factor" for his inclusive treatment of *Matelea*, noting that "were it not for the Antillean species, one might compose a fairly respectable key to several genera upon the continent." As a component of a larger study of *M.* subg. *Ptycanthera*, that ultimately seeks to bear on issues of generic circumscription, this study sought to critically examine patterns of morphological variation within the embedded *M. bayatensis-correllii-tigrina* complex. Resolution of species-level circumscriptions are necessary before larger issues of subgeneric and generic circumscription can be adequately addressed.

METHODS

Based on study of available specimens (Table 1), a matrix of morphological character states (Tables 2 & 3) was developed for seven species and subjected to parsimony analysis using PAUP* (Swofford 2003). Besides *Matelea bayatensis* (Urb.) Woodson, *M. correllii* Spellman, and *M. tigrina* (Griseb.) Woodson (all members of subg. *Ptycanthera* sensu Woodson 1941), the matrix also included three additional West Indian taxa, representing other members of subg. *Ptycanthera*, as well as subg. *Poicilla* sensu Woodson (1941). Closely allied to *Matelea* (Rapini et al. 2003), the type for the genus *Gonolobus* Michx. (i.e., *Gonolobus suberosus* (L.) R.Br.) was chosen as the outgroup (see also Krings & Xiang 2004). The morphological data matrix (Table 2) was comprised of sixteen qualitative characters. Multistate characters were treated as polymorphisms. Bootstrap support values were determined using the branch-and-bound algorithm with 10,000 replicates. To examine phenetic similarity, the morphological character matrix was also subjected to Neighbor-joining (NJ) analysis using PAUP* (Swofford 2003). Continuous data represented by pedicel and corolla lobe length, both characters historically used by authors to delimit taxa in the complex (see Grisebach 1863; Urban 1925), were critically analyzed using ANOVA. In all, thirteen herbarium sheets of *Matelea bayatensis*, *M. correllii*, and *M. tigrina* were examined, although only four individual collections exhibited flowers (Table 1). These specimens essentially represent the sum total of available herbarium specimens of the group, as material was requested from eighty-three institutions known or likely to house material of subtribe Gonolobinae in the West Indies. Only the holotype of *M. correllii* (MO), the lectotype of *M. tigrina* (GOET fide Howard 1988), and a syntype of *M. tigrina* (MO), were not studied as they could not be obtained on loan.

RESULTS

Parsimony.—An exhaustive search using PAUP* (Swofford 2003) evaluated 945 trees and yielded two of shortest length (Length=29; CI=0.862; RI=0.692; Fig. 1). Nine of the sixteen morphological characters (56%) were parsimony informative. The two trees are identical except for resolution of the *Matelea bayatensis-*

TABLE 1. Specimens examined and chosen for analysis.

Subgenus of Matelea sensu Woodson (1941)	Species	Locality	Source
–	*Gonolobus suberosus* (L.) R.Br.	Southeastern U.S.A.	Krings & Xiang (2004)
Poicilla	*Matelea ovatifolia* (Griseb.) Woodson	Cuba, Oriente	*Wright 2965* (ST: G, GH, BREM, UC)
Ptycanthera	*Matelea bayatensis* (Urb.) Woodson	Cuba, Oriente	*Engström 3056* (ST: NY, S)
Ptycanthera	*Matelea correllii* Spellman	Bahamas, Long Island	Spellman (1978), *Correll 49112* (IT: F, FTG, GH, NY, US), *Correll 48157* (topotype: FTG, MO, NY); *Correll 44937* (FTG)
Ptycanthera	*Matelea oblongata* (Griseb.) Woodson	Cuba, Occidente	*Britton & Wilson 14867* (NY), *Britton et al. 7379* (NY), *Ekman 17625* (S), *Leon 17423* (NY), *Shafer 13508* (NY)
Ptycanthera	*Matelea pauciflora* (Spreng.) Woodson	Hispaniola	*Ekman H14296* (S), *Garcia & Pimentel 2531* (MO)
Ptycanthera	*Matelea tigrina* (Griseb.) Woodson	Cuba, Oriente	*Wright 1667* (ST: G, GH)

correllii-tigrina clade. The clade itself appears well-supported by bootstrap values, as is the *Matelea ovatifolia-oblongata* clade. The two Cuban taxa, *Matelea bayatensis* and *M. tigrina* emerged nearer one another than either to *M. correlli* in one of the trees, although with very weak bootstrap support.

NJ and ANOVA.—The neighbor-joining (NJ) analysis showed the Cuban taxa—*M. bayatensis* and *M. tigrina*—to be more similar to each other than either is to the Bahaman taxon *M. correllii* (Fig. 2). The NJ tree is identical to the second of the shortest trees identified by parsimony analysis (Fig. 1, B). *Matelea tigrina* bears sepals that are densely pubescent with both glandular and eglandular hairs and corolla lobes that are pubescent (though not densely so) on the abaxial surface. In contrast, *Matelea correllii* bears glabrous calyces and corollas. *Matelea bayatensis* is intermediate. Its sepals are scattered (not densely) pubescent, with glandular and eglandular hairs, and the abaxial corolla lobes are glabrous. Sepals are lanceolate in *Matelea bayatensis* and *M. tigrina*, and ovate in *M. correllii*. All three taxa in the complex show strong reticulations of their corolla lobes, white dots at the corolla lobe apices, and similar corona and gynostegial morphology. Although pedicel length and corolla lobe length have been used to delimit taxa in the complex (see Grisebach 1863; Urban 1925), an analysis of variance showed no statistically significant difference in mean

TABLE 2. Characters and states scored for the parsimony and neighbor-joining analyses.

Character	State
1. Adaxial leaf blade vestiture	0 = glabrous/glabrate; 1 = pubescent
2. Abaxial leaf blade vestiture	0 = glabrous/glabrate; 1 = pubescent
3. Leaf blade apex	0 = acuminate, 1 = acute or obtuse; 2 = rounded or emarginate
4. Leaf blade bases	0 = cordate; 1 = rounded/truncate; 2 = cuneate
5. Adaxial sepal vestiture	0 = glabrous; 1 = pubescent
6. Abaxial sepal vestiture	0 = glabrous; 1 = pubescent
7. Corolla coloration	0 = uniformly colored; 1 = reticulate; 2 = center differently colored
8. Corolla adornment	0 = absent; 1 = each lobe bearing a white spot apically
9. Corolla lobe shape	0 = broadly ovate to suborbicular; 1 = oblong, triangular-deltate, or lanceolate
10. Adaxial corolla lobe vestiture	0 = glabrous; 1 = pubescent
11. Abaxial corolla lobe vestiture	0 = glabrous; 1 = pubescent
12. Cs (staminal corona, see Kunze 1995)	0 = absent or shallow; 1 = well-developed, and/or foliate
13. Stylar head shape	0 = flat or depressed; 1 = conical
14. Stylar head appendage	0 = absent; 1 = present
15. Cd (dorsal anther appendages, see Kunze 1995)	0 = absent; 1 = present
16. Orientation of pollinium cavity in the gynostegial head	0 = +/- horizontal; 1 = descending

pedicel or corolla lobe length at the 95% confidence level between the three species (pedicel length: $F = 1.98 < F_{crit} = 3.49$; corolla lobe length: $F = 3.65 < F_{crit} = 3.86$). A graphical representation of these data shows evident overlap (Fig. 3).

DISCUSSION

The oldest name in the *Matelea bayatensis-correllii-tigrina* complex was provided by Grisebach (1863) for a Cuban taxon then referred to the genus *Gonolobus*: *G. tigrinus* Griseb. Urban (1925) later added *G. bayatensis* Urb. to the complex, distinguishing it from *G. tigrinus* by shorter pedicels, lanceolate sepals (vs. elliptic-oblong) which are scarcely pilose abaxially (vs. pilose), and longer corolla lobes, these ovate to ovate-rotund (vs. orbicular). A study of the types of both taxa quickly shows these characters to be problematic (*M. tigrina*: *Wright 1667*, G!, GH!; *M. bayatensis*: *Arth. Engström* in herb. Ekman 3056, NY!, S!). Urban's interpretation of sepal and corolla lobe shapes is subjective and these features appear to intergrade. Perhaps his pedicel measurements were not made on extant material, as pedicels on the remaining types are 2.71–3.96 mm long and thus well within the range of *G. tigrinus* (i.e., 2.6–3.69 mm). Furthermore, corollas of *G. tigrinus* were described in Grisebach's protologue as 5–6 mm long,

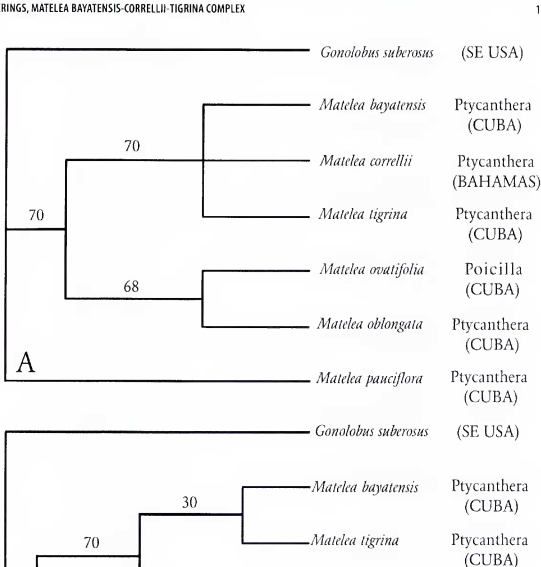

FIG. 1. The two shortest trees (A–B) resulting from a parsimony analysis of morphological characters (exhaustive search) in study of the Antillean *Matelea bayatensis-correllii-tigrina* complex (each tree: length = 29; CI = 0.862; RI = 0.692). Bootstrap support values appear above branches. Marginal annotations indicate subgenus of *Matelea* sensu Woodson (1941) (if applicable), followed by geographic distribution of the species.

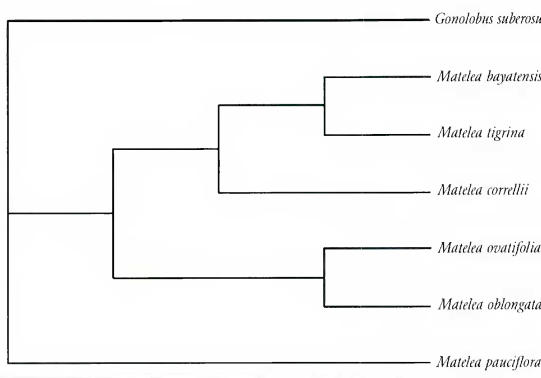

Fig. 2. Neighbor-joining tree showing phenetic similarity in the Antillean *Matelea bayatensis-correllii-tigrina* complex based on sixteen morphological character states.

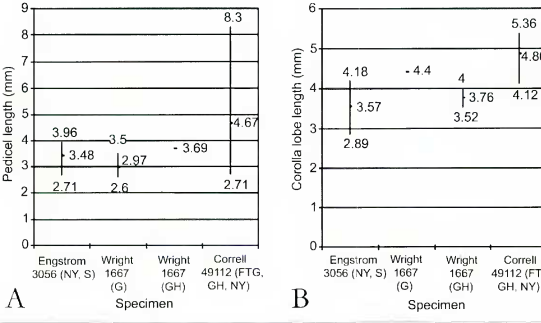

Fig. 3. Continuous floral characters historically used to delimit *Matelea bayatensis*, *M. correllii*, and *M. tigrina*: A, pedicel length; B, corolla lobe length. Measurements indicate maximum, mean, and minimum from top to bottom (in mm), unless only a single measurement was available. *Engström 3056* = *M. bayatensis*; *Wright 1667* = *M. tigrina*; *Correll 49112* = *M. correllii*. The two Wright specimens likely represent two different individuals collected at different times and localities (see Howard 1988).

TABLE 3. Morphological character matrix used in the parsimony and neighbor-joining analyses of the *Matelea bayatensis-correllii-tigrina* complex.

Taxon	Character states
Gonolobus suberosus	{01}10001{02}01{01}110010
Matelea bayatensis	001{01}011100001000
Matelea correllii	0011001100001000
Matelea oblongata	00{01}{12}000010021001
Matelea ovatifolia	001{01}000001020001
Matelea pauciflora	{01}1{12}10100010001100
Matelea tigrina	001{01}011100101000

just a millimeter shorter than *G. bayatensis*. When dried both taxa have similar corolla lobe lengths (to 4.18 mm in *G. bayatensis*; to 4.4 mm in *G. tigrinus*)—although differential shrinkage has been shown in other *Matelea* species (see Drapalik 1969). The sepal vestiture trait remains true. However, this seems insufficient basis for recognizing two separate species.

Without publishing a critical study of the complex, Woodson (1941) later provided new combinations for both taxa in *Matelea*, applying his concept that *Gonolobus* should be characterized primarily by dorsal anther appendages and smooth, winged follicles. Dorsal anther appendages appear to be lacking in both *M. tigrina* and *M. bayatensis*. Follicles of the two were unknown to Woodson (1941), as they are today, as both species are known only from the type specimens, none of which bear fruit. However, the interpretation of the presence of dorsal anther appendages can be difficult from herbarium specimens. At least six species transferred from *Gonolobus* to *Matelea* by Woodson (1941) were considered by Schlechter (1899) and Urban (1925) to bear dorsal anther appendages to some degree. The controversial taxa fall into two *Matelea* subgenera sensu Woodson (1941)—*Pachystelma* and the Antillean *Ptycanthera*—and include *M. bayatensis* and *M. tigrina*. The utility of the follicle character (primarily winged in *Gonolobus* vs. primarily muricate in *Matelea*) is also problematic. With greater collections since Woodson (1941), it has become clear that several taxa apparently lacking dorsal anther appendages bear winged instead of muricate follicles. These taxa include the more recently described *Matelea correllii* Spellman (1978) from the Bahamas, which bears extreme resemblance in habit, foliar, and floral characters to *M. bayatensis* and *M. tigrina*.

Matelea bayatensis, *M. correllii*, and *M. tigrina* are clearly closely related morphologically (Figs. 1–3). The three taxa appear to differ only in pubescence and relatively minor floral character states, some of which overlap (Fig. 3). This minor variation may be due to the very limited number of collections and might be completely indistinct if more collections were available. Flower sizes (including pedicel lengths) can likely be influenced by growing conditions, as can

pubescence. At present, none of the observed variation appears important enough to warrant the continued recognition of three distinct species. At the least, based on current evidence (albeit limited), the two Cuban species—*Matelea bayatensis* and *Matelea tigrina*—can be considered synonymous. Considering geographic distribution, that the Cuban taxa appear more closely related to each other than each is to the Bahaman taxon, and that *Gonolobus tigrinus* is the oldest basionym, it also seems appropriate to treat the Bahaman taxon as a subspecies within *Matelea tigrina*. The question of whether the species should be referred to *Gonolobus* cannot yet be answered based on the material at hand. On-going work toward a robust phylogeny based on molecular data aims to address this question. Until then, new combinations are avoided to limit unnecessary names.

TAXONOMIC TREATMENT

Matelea tigrina (Griseb.) Woodson, Ann. Missouri Bot. Gard. 28:226. 1941. *Gonolobus tigrinus* Griseb., Mem. Amer. Acad. Arts ser. 2, 8:520. 1863. TYPE: CUBA: *Wright 1667*, 1860 (LECTOTYPE: GOET (fide Howard 1988); SYNTYPES: MO [image online!], G!, GH!).

Gonolobus bayatensis Urb., Symb. Antill. 9(3):420–421. 1925. [synon. nov.] *Matelea bayatensis* (Urb.) Woodson, Ann. Missouri Bot. Gard. 28:226. 1941. TYPE: CUBA: *Arth. Engström* in herb. *Ekman n. 3056* (SYNTYPES: NY!, S!).

Matelea correllii Spellman, Ann. Missouri Bot. Gard. 65:1255–1257. 1978. [synon. nov.] TYPE: BAHAMAS. LONG ISLAND: *D.S. Correll 49112* (HOLOTYPE: MO; ISOTYPES: F!, FTG!, GH!, NY!, US!)

Distribution.—The putative subspecific entity comprised by *M. tigrina* and *M. bayatensis* is apparently restricted to Cuba. The putative subspecific entity comprised by *M. correllii* is apparently endemic to the Bahamas.

Notes.—Spellman's (1978) note of a resemblance between *M. correllii* and *M. grisebachiana* (Schltr.) Alain is puzzling as the latter was described with leaves only to 0.7 cm wide (initially described as *Gonolobus tigrinus* var. *angustifolius* Griseb.) and oblong corolla lobes. Leaves of *M. correllii* average 1.5–2.5 cm diam. Schlechter (1899) also noted differences between *M. tigrina* and *M. grisebachiana* in the outer corona and in the presence of conspicuous dorsal anther appendages ('Cd' sensu Kunze 1995) in the latter. Unfortunately, the type of *M. grisebachiana* (Cuba, *Wright s.n.*) has not yet been located and may have been destroyed. Additional specimens of *M. grisebachiana* have also not been located and could thus not be analyzed.

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Gonolobinae material, although finding no representation: BG, BKL, BR, BUF, COLO, CR, FLAS, IA, ISC, LD, MSU, NEU, NSW, UPS, TUR. The assistance of the North Carolina State University Libraries Inter-Library Loan Service is also gratefully acknowledged, as are the manuscript reviews by Bruce Hansen and Justin Williams.

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